- The Magnitude-Phase Representation of the Fourier Transform (p.423)
- The Magnitude-Phase Representation of Frequency Response of LTI Systems (p.427)
- Time-Domain Properties of Ideal Frequency-Selective Filters
- Time-Domain and Frequency-Domain Aspects of Non-ideal Filters
- 1st-Order & 2nd-Order Continuous-Time Systems
- p.461 1st-Order & 2nd-Order Discrete-Time Systems
- Time- & Frequency-Domain Analysis of Systems

6.17: DT Difference Equation, Oscillatory

6.17. For each of the following second-order difference equations for causal and stable LTI systems, determine whether or not the step response of the system is oscillatory:

(a) $y[n] + y[n-1] + \frac{1}{4}y[n-2] = x[n]$

(b) $y[n] - y[n-1] + \frac{1}{4}y[n-2] = x[n]$

6.3. Consider the following frequency response for a causal and stable LTI system:

$$H(j\omega) = \frac{1 - j\omega}{1 + j\omega}.$$

(a) Show that $|H(j\omega)| = A$, and determine the value of A.

(b) Determine which of the following statements is true about $\tau(\omega)$, the group delay of the system. (*Note:* $\tau(\omega) = -d(\sphericalangle H(j\omega))/d\omega$, where $\sphericalangle H(j\omega)$ is expressed in a form that does not contain any discontinuities.)

1. $\tau(\omega) = 0$ for $\omega > 0$
2. $\tau(\omega) > 0$ for $\omega > 0$
3. $\tau(\omega) < 0$ for $\omega > 0$

6.4. Consider a linear-phase discrete-time LTI system with frequency response $H(e^{j\omega})$ and real impulse response $h[n]$. The group delay function for such a system is defined as

$$\tau(\omega) = -\frac{d}{d\omega} \sphericalangle H(e^{j\omega}),$$

where $\sphericalangle H(e^{j\omega})$ has no discontinuities. Suppose that, for this system,

$$|H(e^{j\pi/2})| = 2, \quad \sphericalangle H(e^{j0}) = 0, \quad \text{and} \quad \tau\left(\frac{\pi}{2}\right) = 2.$$

Determine the output of the system for each of the following inputs:

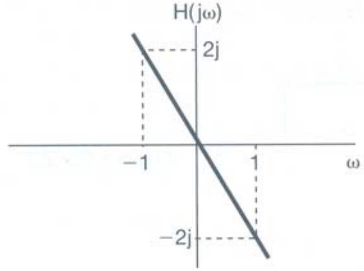
(a) $\cos(\frac{\pi}{2}n)$ **(b)** $\sin(\frac{7\pi}{2}n + \frac{\pi}{4})$

6.21: Filtered Output

6.21. A causal LTI filter has the frequency response $H(j\omega)$ shown in Figure P6.21. For each of the input signals given below, determine the filtered output signal $y(t)$.

(a) $x(t) = e^{jt}$ **(b)** $x(t) = (\sin \omega_0 t)u(t)$

(c) $X(j\omega) = \frac{1}{(j\omega)(6+j\omega)}$ **(d)** $X(j\omega) = \frac{1}{2+j\omega}$



6.25: Group Delay, Nonlinear Phase

6.25. By computing the group delay at two selected frequencies, verify that each of the following frequency responses has nonlinear phase.

(a) $H(j\omega) = \frac{1}{j\omega+1}$ **(b)** $H(j\omega) = \frac{1}{(j\omega+1)^2}$ **(c)** $H(j\omega) = \frac{1}{(j\omega+1)(j\omega+2)}$